COSEWIC
Assessment and Update Status Report

on the

Northern Goshawk
Laingi subspecies

Accipiter gentilis laingi

in Canada

THREATENED
2000

COSEWIC
COMMITTEE ON THE STATUS OF
ENDANGERED WILDLIFE
IN CANADA

COSEPAC
COMITÉ SUR LA SITUATION DES
ESPÈCES EN PÉRIL
AU CANADA

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COSEWIC 2000. COSEWIC assessment and update status report on the Northern Goshawk *Laingi* subspecies *Accipiter gentilis laingi* in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. vi + 36 pp. (www.sararegistry.gc.ca/status/status_e.cfm)

Cooper, J.M. and P.A. Chytyk. 2000. Update COSEWIC status report on the Northern Goshawk *Laingi* subspecies *Accipiter gentilis laingi* in Canada, *in* COSEWIC assessment and update status status report on the Northern Goshawk *Laingi* subspecies *Accipiter gentilis laingi* in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. 1-36 pp.

Previous Report

Duncan P. and D.A. Kirk. 1995. COSEWIC status report on the Queen Charlotte Goshawk *Accipiter gentilis laingi* in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. 44 pp.

Production note:
The Northern Goshawk *laingi* subspecies *Accipiter gentilis laingi* was formerly designated by COSEWIC as the Queen Charlotte Goshawk *Accipiter gentilis laingi*. Throughout the status report the species is referred to as the Queen Charlotte Goshawk which is a subspecies of the Northern Goshawk.

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Également disponible en français sous le titre Rapport du COSEPAC sur la situation de l'Autour des palombes de la sous-espèce laingi (*Accipiter gentilis laingi*) au Canada – Mise à jour.

Cover illustration:
Northern Goshawk *laingi* subspecies — illustration by Judy Shore, Richmond Hill, Ontario.

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Catalogue No. CW69-14/12-2002E-IN
ISBN 0-662-32941-4

Recycled paper

COSEWIC
Assessment Summary

Assessment Summary – November 2000

Common name
Northern Goshawk *laingi* subspecies

Scientific name
Accipiter gentilis laingi

Status
Threatened

Reason for designation
This small, sedentary goshawk population has been negatively impacted by degradation of forested habitat.

Occurrence
British Columbia

Status history
Designated Special Concern in April 1995. Status re-examined and designated Threatened in November 2000. Last assessment based on an update status report.

COSEWIC
Executive Summary

Northern Goshawk
Laingi subspecies
Accipiter gentilis laingi

The Northern Goshawk *laingi* subspecies (*Accipiter gentilis laingi*) is a subspecies of the Northern Goshawk (*A. gentilis*) that occurs only on the Pacific coast of North America. It is resident from southeastern Alaska through coastal British Columbia, and probably south to the Olympic Peninsula of Washington. Throughout the status report the species is referred to as the Queen Charlotte Goshawk which is a subspecies of the Northern Goshawk. Populations and range of the Queen Charlotte Goshawk are relatively very small compared to those for Northern Goshawk, which occurs over much of northern North America. In British Columbia, populations of the Queen Charlotte Goshawk are likely restricted to Vancouver Island, the Queen Charlotte Islands, and other large coastal islands. The status of Northern Goshawks on the coastal mainland remains uncertain, however, recent studies suggest that some Queen Charlotte Goshawks could occur there.

Habitat modeling suggests that most of the global population of the Queen Charlotte Goshawk occurs in British Columbia. Recent surveys on Vancouver Island and Queen Charlotte Islands suggested most of the provincial population occurs on Vancouver Island. We estimate about 300 breeding pairs on Vancouver Island and 50 breeding pairs on the Queen Charlotte Islands, but lack of surveys or habitat assessments in many areas make these estimates very uncertain.

Significant threats to habitat include continued logging of preferred, low elevation, old-growth coniferous forest and suitable mature second-growth forest. Habitat modeling suggests that populations have declined from historical numbers because habitat has been significantly degraded. We predict that declines will continue as old-growth forests continue to be logged and harvest rotations shorten for second-growth forests, resulting in some permanent loss of suitable Queen Charlotte Goshawk habitat in large parts of managed forests.

COSEWIC MANDATE

The Committee on the Status of Endangered Wildlife in Canada (COSEWIC) determines the national status of wild species, subspecies, varieties, and nationally significant populations that are considered to be at risk in Canada. Designations are made on all native species for the following taxonomic groups: mammals, birds, reptiles, amphibians, fish, lepidopterans, molluscs, vascular plants, lichens, and mosses.

COSEWIC MEMBERSHIP

COSEWIC comprises representatives from each provincial and territorial government wildlife agency, four federal agencies (Canadian Wildlife Service, Parks Canada Agency, Department of Fisheries and Oceans, and the Federal Biosystematic Partnership), three nonjurisdictional members and the co-chairs of the species specialist groups. The committee meets to consider status reports on candidate species.

DEFINITIONS

Species	Any indigenous species, subspecies, variety, or geographically defined population of wild fauna and flora.
Extinct (X)	A species that no longer exists.
Extirpated (XT)	A species no longer existing in the wild in Canada, but occurring elsewhere.
Endangered (E)	A species facing imminent extirpation or extinction.
Threatened (T)	A species likely to become endangered if limiting factors are not reversed.
Special Concern (SC)*	A species of special concern because of characteristics that make it particularly sensitive to human activities or natural events.
Not at Risk (NAR)**	A species that has been evaluated and found to be not at risk.
Data Deficient (DD)***	A species for which there is insufficient scientific information to support status designation.

* Formerly described as "Vulnerable" from 1990 to 1999, or "Rare" prior to 1990.
** Formerly described as "Not In Any Category", or "No Designation Required."
*** Formerly described as "Indeterminate" from 1994 to 1999 or "ISIBD" (insufficient scientific information on which to base a designation) prior to 1994.

The Committee on the Status of Endangered Wildlife in Canada (COSEWIC) was created in 1977 as a result of a recommendation at the Federal-Provincial Wildlife Conference held in 1976. It arose from the need for a single, official, scientifically sound, national listing of wildlife species at risk. In 1978, COSEWIC designated its first species and produced its first list of Canadian species at risk. Species designated at meetings of the full committee are added to the list.

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Canada

The Canadian Wildlife Service, Environment Canada, provides full administrative and financial support to the COSEWIC Secretariat.

Update
COSEWIC Status Report

on the

Northern Goshawk
Laingi subspecies

Accipiter gentilis laingi

in Canada

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2000

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SPECIES INFORMATION

Common names of species:	Northern Goshawk *Laingi* subspecies Queen Charlotte Goshawk subspecies of Northern Goshawk
Scientific name:	*Accipiter gentilis laingi*
Classification:	Bird

Description and Taxonomy

The Queen Charlotte Goshawk is a subspecies of Northern Goshawk (hereafter goshawk), a medium-sized, robust forest raptor. Three subspecies have been recognized in North America: *A. g. atricapillus*, *A. g. apache* and *A. g. laingi*, the Queen Charlotte Goshawk. *A. g. atricapillus* is found throughout forested areas of North America, except on the northwest coast, the extreme southwest USA, and Mexico (Squires and Reynolds 1997). *A. g. apache* occurs in southern Arizona, New Mexico and Mexico (Whaley and White 1994). A. g. laingi (Queen Charlotte Goshawk) occurs in southeast Alaska (Titus *et al.* 1994), on the coastal islands of British Columbia (American Ornithologists' Union 1957), and, perhaps, the Olympic Peninsula (Beebe 1974). These subspecies are defined on the basis of colour and morphological differences (Taverner 1940), but the genetic validity of the *apache* and *laingi* subspecies is under debate. No significant genetic differences were found in blood samples of the three subspecies (Gavin and May 1995), but samples from Vancouver Island or the Queen Charlotte Islands, which are the core range for Queen Charlotte Goshawks (Iverson *et al.* 1996) were not used in the analysis. Flatten *et al.* (1998) compared morphometric data from captured birds in southeast Alaska and Vancouver Island, and from museum specimens from the Queen Charlotte Islands, and confirmed that the Queen Charlotte Goshawk is smaller and darker than *A. g. atricapillus*.

DISTRIBUTION

Global

Goshawks are widely distributed in boreal and temperate forests of the Holarctic. In North America, it ranges from near the tree line in Alaska and northern Canada south to Mexico in the west, and Pennsylvania in the east. In Eurasia, it occurs from Great Britain, Scandinavia, northern Russia, and Siberia south to southern Europe, Iran, the Himalayan Mountains, eastern China, and Japan (American Ornithologists' Union 1983; Squires and Reynolds 1997).

North America

Goshawks are resident in forested areas from near tree line in west-central Alaska across northern Canada. On the Pacific coast, it is resident south to Washington. In the interior, it is resident south throughout Canada to the southwestern USA, northern

Mexico, the Great Lakes states, and the Appalachian Mountains in northeastern USA. (American Ornithologists' Union 1983; Johnsgard 1990; Marshall 1992; Duncan and Kirk 1995; Braun *et al.* 1996; Squires and Reynolds 1997). The Queen Charlotte Goshawk occurs in southeast Alaska (Titus *et al.* 1994), on the coastal islands of British Columbia (American Ornithologists' Union 1957), and the Olympic Peninsula (Beebe 1974), and, perhaps, coastal Washington and Oregon (Jewett *et al.* 1953). See Figure 1.

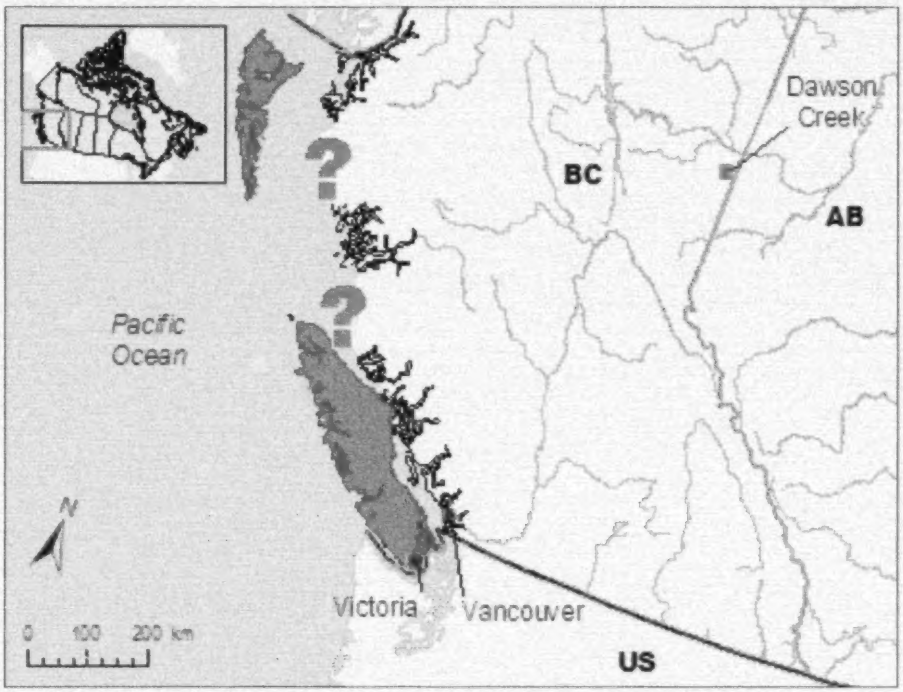

Figure 1. Canadian distribution of the Northern Goshawk *laingi* subspecies.

Canada

In Canada, goshawks are resident throughout forested parts of the country from the Yukon south through British Columbia, across the northern forested parts of the prairie provinces, and most of Ontario, Quebec, and Labrador (Duncan and Kirk 1995; Squires and Reynolds 1997). The Queen Charlotte Goshawk occurs only in coastal British Columbia (Campbell *et al.* 1990), mainly on the Queen Charlotte Islands and Vancouver Island (American Ornithologists' Union 1957), and probably on other large coastal islands (McClaren 1997). Although evidence for occurrence on the coastal mainland of British Columbia is generally lacking (T. Ethier pers. comm. in Duncan and Kirk 1995; R.W. Campbell pers. comm. in Crocker-Bedford 1994), it seems likely that the Queen Charlotte Goshawk occurs on the north and central mainland coast. For example, one radio-tagged Queen Charlotte Goshawk, originally captured on northeastern Vancouver Island, dispersed to Loughborough Inlet on the coastal mainland, 15 km from Vancouver Island (D. Doyle pers. comm.).

HABITAT

General

Goshawks are habitat generalists on large spatial scales, but have a complexity of habitat needs during the breeding season, the specifics of which vary among forest types and regions (Johnsgard 1990). Although goshawks may breed in younger, more even-aged stands, they tend to choose breeding areas which have stands with relatively large amounts of mature or old-growth trees or stand characteristics (Squires and Reynolds 1997; McClaren 1998). These stands do not necessarily need to be continuous, but substantial amounts seem to be preferred.

Eight characteristics common to the goshawk nesting area in western North America include: 1)presence of mature to old-growth forests; 2) canopy closure >60%; 3) open understory; 4) gentle to moderate slopes of <40%, (nests are generally on benches, slope toes or level ground); 5) lower third or bottom of slope; 6) northerly exposure, northeast to northwest; 7) often close to a perennial water source; and 8) proximity to an abundant prey base (Marshall 1992; Duncan and Kirk 1995). Larger diameter at breast height (dbh) trees are also thought to be important (Daw *et al.* 1998).

High canopy closure is the single most consistent nesting habitat feature for goshawks across their range (Squires and Reynolds 1997; Daw *et al.* 1998). Relatively closed stands provide protection from predators and promote more open spaces under the canopy that allows clear flight paths for striking prey. Small forest openings, such as where one or two trees have fallen and left more open air space near the nest tree, are often associated with nest sites (Reynolds *et al.* 1982). On the Queen Charlotte Islands, all nests of the Queen Charlotte Goshawk found recently have occurred in small forest openings (Chytyk and Dhanwant 1997); a characteristic also noted for some nests on Vancouver Island (E. McClaren pers. comm.).

Nesting Habitat

Stands used for nesting vary in size and shape, depending on topography and availability of suitable stands. Nests were usually situated on benches or slopes with a gentle to moderate incline (<40%), and at the bottom or lower 1/3 of the slope (Duncan and Kirk 1995). On Vancouver Island, Queen Charlotte Goshawk nests were generally located on the bottom two-thirds of a slope, at lower elevations of moderate slopes (McClaren 1999). Forty active or alternate nest trees on Vancouver Island averaged an elevation of 392 m (McClaren 1998). On the Queen Charlotte Islands, 5 active nests were found in the bottom third of gentle slopes, average elevation of 178 m and slope of 26° (Chytyk and Dhanwant 1999; Chytyk *et al.* 1999).

In temperate forests of North America, nest stands tend to face north, but in boreal forests, southern aspects may be preferred (Speiser and Bosakowski 1987; Doyle and Smith 1994). Considerable variation occurs in British Columbia. Goshawks in the Kispiox Forest District of northwestern interior British Columbia preferred northeast-

facing slopes (Mahon and Franklin 1997), whereas Queen Charlotte Goshawks on the Queen Charlotte Islands, which is at the same latitude as Kispiox, used only southwest-facing slopes (Chytyk and Dhanwant 1999; Chytyk *et al.* 1999). On Vancouver Island, Queen Charlotte Goshawks nested on all aspects (McClaren 1999). Although the sample from the Queen Charlotte Islands was small, there may be a significant difference in aspect preference between Queen Charlotte Goshawks on Vancouver Island and those on the Queen Charlotte Islands.

Stands used for nesting generally have trees that are taller and older than in surrounding forests. These stands typically have a relatively high proportion of larger trees and a higher canopy closure (Reynolds *et al.* 1982; Moore and Henny 1983; Speiser and Bosakowski 1987; Crocker-Bedford and Chaney 1988; Iverson *et al.* 1996; Bosakowski and Rithaler 1997; McClaren 1998; Chytyk and Dhanwant 1999). Canopy closure has been documented to range from 51% to 94%, but is almost always >60%. High canopy closure may provide protection from avian predators such as Red-tailed Hawks (*Buteo jamaicensis*), Great Horned Owls (*Bubo virginianus*), and corvids (Moore and Henny 1983; Crocker-Bedford and Chaney 1988; Crocker-Bedford 1990b), provide thermal cover (Reynolds *et al.* 1982; Hall 1984), and promote more open spaces under the canopy and in the undergrowth that allows clear flight paths (Squires and Reynolds 1997).

On Vancouver Island, of 56 Queen Charlotte Goshawk nests, 62% were found in contiguous old-growth forests, 25% in contiguous second-growth forests, and 13% in fragmented old-growth forests (McClaren 1999). The youngest-aged stand which contained a nest was 53 years. On the Queen Charlotte Islands, 4 Queen Charlotte Goshawk nests were found in contiguous western hemlock (*Tsuga heterophylla*) old-growth stands (Chytyk and Dhanwant 1999), while another active nest was found in contiguous western hemlock old-growth forest that was bordered by mature western hemlock that contained 2 alternate nests (Chytyk *et al.* 1999). In southeast Alaska, minimum amounts of old-growth forests in Queen Charlotte Goshawk use areas (areas in which radio locations were made of radio-tagged nesting birds) were 23% and 28% for males and females respectively. In areas with less than those amounts of old-growth forest there was no use (Iverson *et al.* 1996); however, the study area contained virtually no mature forest (K. Titus pers. comm.).

Goshawk nest trees tend to be the largest, or one of the largest, trees in the stand (Reynolds *et al.* 1982; Speiser and Bosakowski 1987; Squires and Ruggerio 1996; Daw *et al.* 1998; Rosenfield *et al.* 1998; Bosakowski 1999). In British Columbia, this trend also occurred with the Queen Charlotte Goshawk (McClaren 1998; Chytyk and Dhanwant 1999; T. Ethier pers. comm.). Larger trees provide structural support for nests including: strong lateral branches, crotches, or defects, such as broken tops or mistletoe structures. In pole-stage Douglas-fir (*Pseudotsuga menziesii*) forests in western Washington, where tree branches did not provide suitable nest sites, mistletoes or tree deformities provided structural support for nests (Fleming 1987). On the Queen Charlotte Islands, several Queen Charlotte Goshawk nests were located on mistletoe structures on dead old-growth western hemlocks (Chytyk and Dhanwant 1997). See

Appendix A for a summary of nest tree characteristics from selected studies in North America.

A variety of coniferous and deciduous tree species are commonly used by goshawks as nest trees: Oregon - ponderosa pine (Pinus ponderosa), lodgepole pine (P. contorta), Douglas-fir and western larch (*Larix occidentalis*) (DeStefano and Meslow 1992; Reynolds *et al.* 1982; Bull and Hohmann 1994); southeast Alaska - Sitka spruce (*Picea sitchensis*) and western hemlock (Titus *et al.* 1994); interior Alaska - paper birch (*Betula papyrifera*) (McGowan 1975); Yukon - spruce or trembling aspen (Populus tremuloides) (Doyle and Smith 1994). In British Columbia, records of nest trees included mainly trembling aspen and Douglas-fir, but black cottonwood (*P. balsamifera trichocarpa*), western larch, ponderosa pine, lodgepole pine, paper birch and spruce were also used (Campbell *et al.* 1990; T. Antifeau pers. comm.). In the Cariboo Region, nest trees included Douglas-fir, lodgepole pine, and trembling aspen (Bosakowski and Rithaler 1997). In the Kispiox Forest District, nests were in mature or old-growth western hemlock or amabilis fir (*Abies amabilis*) (Mahon and Franklin 1997).

On Vancouver Island, most nest trees were live Douglas-firs and western hemlocks, however, red alder (*Alnus rubra*), Sitka spruce and western redcedar (*Thuja plicata*) were also used (McClaren 1999). The variety of nest tree species selected by Queen Charlotte Goshawks on Vancouver Island suggests that they may select for forest and nest tree structure, not nest tree species (McClaren 1999). On the Queen Charlotte Islands, 4 of 5 active nests were in dead western hemlocks, while the fifth was in a live western hemlock (Chytyk *et al.* 1999). Both western hemlock and Sitka spruce were used as alternate nest tree species on the Queen Charlotte Islands.

Foraging Habitat

Goshawks require relatively large foraging areas due to the relative scarcity of their prey and, consequently, they generally have large breeding season home ranges. Typically, goshawk prey species diversity decreases with increasing latitude (Johnsgard 1990); as a result, there is a general trend of increased breeding season home range size with higher latitude. Also, prey species diversity is lower on Vancouver Island and Queen Charlotte Islands compared to the adjacent mainland because of lower prey species diversity on coastal islands (Stevens 1995). In southeast Alaska, median breeding season use areas for males and females varied between 4,400 and 3,600 ha respectively (Titus *et al.* 1996). Elsewhere, home ranges were approximately 5000 ha in the foothills of Alberta (Schaffer *et al.* 1996); from 1842 to 4214 ha on the Olympic Peninsula in Washington (Finn *et al.* 1998); from 1083 to 6908 ha in Oregon (Austin 1993); from 860 to 2530 ha (Bright-Smith and Mannan 1994) or 2025 to 2430 ha in Arizona (Reynolds *et al.* 1992); and were 1550±890 ha in California (Hargis *et al.* 1994). Winter home ranges are poorly described.

Prey abundance and prey availability drive the use of foraging habitat, and prey availability is usually affected by vegetation structural attributes. Consequently, goshawks forage in areas that have the following attributes: 1) adequate prey;

2) sufficient cover to conceal the goshawk's approach to prey; 3) sufficient openings in cover so that prey cannot escape or flight paths are not obstructed; and 4) suitable perches available for the goshawk's spot and attack hunting method (Beebe 1974; Kenward 1982; Reynolds and Meslow 1984; Widen 1989; Johnsgard 1990; Beier and Drennan 1997; Squires and Reynolds 1997). When prey are particularly abundant, natural openings, forest edges, clearcuts and even agricultural lands may be used for foraging. However, goshawks may be excluded from these niches by other raptor species, such as Red-tailed Hawk, which are better adapted to treeless environments (Kenward and Widen 1989; Widen 1989; Crocker-Bedford 1990a; Marshall 1992).

Goshawks forage in all layers of a forest, from the ground up to the aerial zones above the canopy, but tend to concentrate efforts in the ground-shrub layer (Reynolds and Meslow 1984). The large body size and hunting strategies of goshawks precludes the use of young, densely stocked stands for foraging (Reynolds *et al.* 1982; Moore and Henny 1983; Hayward and Escano 1989; Duncan and Kirk 1995; Squires and Ruggerio 1996). Therefore, regenerating early seral stages are less suitable as foraging habitat. Clearcuts may be used for foraging until trees reach a size where goshawks cannot easily penetrate stems or foliage. For example, in an intensely harvested forest in western Washington, Blue Grouse (Dendragaous obscurus) occurred abundantly in regenerating clearcuts. They also represented a relatively high proportion of goshawk diet (Bosakowski *et al.* 1999) compared to goshawks in less intensely-harvested U.S national forests where they relied more on forest-interior birds (Reynolds and Meslow 1984; Bull and Hohmann 1994).

Although edges, small open areas, and clearcuts (Bosakowski *et al.* 1999) can be used for foraging, and seem to be regularly used by goshawks in interior British Columbia (Beebe 1974), the Queen Charlotte Goshawk seems to use unbroken forests more frequently for foraging, and have less association with edges (Iverson *et al.* 1996). In southeast Alaska, Queen Charlotte Goshawks showed a strong preference for old-growth and mature forests, and tended to avoid early successional stands and clearcuts (Titus *et al.* 1994, 1995). On Vancouver Island, three territorial male Queen Charlotte Goshawks showed variable use of old-growth and second-growth habitat in 1997; one male consistently used only old growth, while two other males used second growth more than old growth (E. McClaren, unpubl. data). The second-growth stands were mostly between 60 and 100 years old, but stands as young as 40 years old were used occasionally. These data cannot be used to infer that younger stands are used more often by some individuals since there were no data on use versus habitat availability; however, it is apparent a variety of habitats are used for foraging. During winter 1997, radio-tagged Vancouver Island birds mainly frequented large contiguous stands of old growth and >60 year old second growth (D. Doyle pers. comm.).

Trends in Habitat Quality

In coastal British Columbia, second-growth stands on good growing sites can become suitable for nesting Queen Charlotte Goshawks after >50 years, as several nests have been found in such stands on Vancouver Island (McClaren 1999; D. Doyle

pers. comm.). If logging rotations of 100 years were standard, then provision of extensive amounts of suitable second-growth breeding habitat could be ensured. However, it is becoming increasingly common for second-growth stands that are 50-60 years, and which have size and structure suitable for goshawks, to be logged because of the timber values represented by trees of that size. The result is that once an old-growth stand is logged, it may be continually logged as second growth just as it is becoming suitable for goshawks. Consequently, these stands would not recover sufficiently to provide habitat suitable for nesting goshawks.

On Vancouver Island, Queen Charlotte Goshawk nests that were in contiguous second growth and fragmented forests generally had a lower re-occupancy rate than nests in contiguous old growth. In 1998, 25% of 8 nests in contiguous second growth and 20% of 5 nests in fragmented forests were re-occupied, compared to 83% of 12 nests in contiguous old-growth forests (McClaren 1999).

Protection/Ownership of Habitat

Considerable amounts of forested land on Vancouver Island and the Queen Charlotte Islands are protected from logging by virtue of being in national parks, provincial parks, ecological reserves, or other protected areas (Table 1). On the Queen Charlotte Islands, about 96% of protected forests are in two reserves, Naikoon Provincial Park (69,198 ha, ne corner of Graham Island) and Gwaii Haanas National Park Reserve (148,658 ha, southern portion of Moresby Island).

On Vancouver Island, Strathcona Provincial Park (253,773 ha) is the single most significant protected forested area, but in recent years, many new areas totalling over 150,000 ha, most of which are forested, have been given protected status through the British Columbia Protected Areas Strategy (LUCO 1996). Over 99,000 ha in 47 parcels, mainly in northern and western Vancouver Island, have been protected from logging between 1992 and 1996. Of these 47 parcels, 14 are over 1,000 ha, with the largest being 22,800 ha. In addition, over 63,000 ha in 15 parcels have been conserved in the Clayoquot Sound area, near Pacific Rim National Park.

Table 1. Percentage of forests in protected areas on Vancouver Island and the Queen Charlotte Islands.

[data from BC Ministry of Forests (MOF) and BC Land Use Coordination Office (LUCO)*].

	% of forested land base in protected areas (all BEC zones)	% of low elevation (CDF, CWH) forested land base in protected areas	% of high elevation (MH) forested land base in protected areas
Vancouver Island	11.8	9.8	28.0
Queen Charlotte Islands	22.4	23.0	16.8

*Data were derived from an interpretation of the biogeoclimatic units that are predominately forested (Del Meidinger, MOF Research Branch, pers. comm.) over-layed with the protected areas (from LUCO).

Unfortunately, few assessment of Queen Charlotte Goshawk populations or habitat suitability has been conducted in these protected areas. Therefore, the relative value to goshawks of most of these protected lands is uncertain. It is likely that some protected areas contain relatively large amounts of suitable goshawk habitat, whereas others with high proportions of high elevation forests, very steep and/or rocky terrain contain little suitable habitat. Two nests were found in Strathcona Park, Vancouver Island in 1995, and some inventory was conducted, with no nests found, in Schoen Lake Park, Vancouver Island in 1996 (E. McClaren pers. comm.).

Forested lands that do not occur in protected areas (88% on Vancouver Island, 78% on Queen Charlotte Islands) are either privately-owned or are part of Tree Farm License (TFL) areas that are leased to industry. There are few controls on harvesting of forests on private lands; essentially landowners have few, if any, restrictions on what they can harvest. In forests leased to industry, provisions for maintaining biodiversity values in the TFL area fall under the BC Forest Practices Code (Ministry of Forests 1995). Of particular importance to the Queen Charlotte Goshawk, 7-28% of the forested land base must be retained as old forest, depending on whether an area is classed as a low to high biodiversity emphasis (Ministry of Forests 1995).

The Queen Charlotte Goshawk has been "identified" by the Chief Forester and the Deputy Minister of Environment, Lands and Parks as requiring special attention under the Forest Practices Code. As Identified Wildlife, it is part of the *Identified Wildlife Management Strategy* (IWMS) (Province of British Columbia 1999). This strategy contains specific management practices referred to as General Wildlife Measures (GWMs) that outline what forest and range practices can occur within designated species-specific conservation areas called Wildlife Habitat Areas (WHAs). For the Queen Charlotte Goshawk, the establishment of a "three-tiered" WHA (total 2,400 ha) at selected breeding sites and associated foraging areas is recommended. Three suitable and three replacement nest areas of 12 ha each are restricted from any forest practices. Limited timber harvesting is permitted within the rest of the WHA during specified times (outside the courtship and nesting period for active nests) and in a manner that adheres to a specified distribution of seral stages. This distribution includes 20% closed canopy old forest, 40% mature forest and not more than 20% young forest. The definition of young, mature and old forests varies with natural disturbance type and biogeoclimatic zone; all definitions can be found in the Biodiversity Guidebook (Ministry of Forests 1995).

However, a planning threshold has been implemented that will prevent the unlimited application of WHAs for Queen Charlotte Goshawks. Each forest district will have a 1% threshold on the timber impact associated with the application of WHAs, for all species of "identified" wildlife, not just Queen Charlotte Goshawks. In effect, this amounts to a limit of only a handful of WHAs available for conservation of Queen Charlotte Goshawk habitat in British Columbia, given that a WHA may be as large as 2,400 ha. This threshold will be in effect for two years, or until conservation assessments are developed that can aid in the redistribution of the provincial 1% limit between forest districts. Establishment of WHAs can only thus be expected to conserve habitat for a few pairs of Queen Charlotte Goshawks.

The use of riparian management areas (RMAs), wildlife tree patches (WTPs), sensitive areas, and management for vegetative species composition and coarse woody debris, present additional opportunities to protect goshawk nest sites and suitable foraging habitat (Ministry of Forests 1995). In addition, since old forest retention recommendations are specified for dominant forest covers within natural disturbance types, landscape units can potentially be managed to maximize the retention of suitable goshawk habitat.

GENERAL BIOLOGY

Reproduction

Goshawks form a monogamous pair bond and show strong mate (Detrich and Woodbridge 1994) and nesting area fidelity between years (Crocker-Bedford 1990a; Reynolds and Joy 1998). However, about 25% of breeding females breed in different areas one year to the next (P. Kennedy pers. comm.). Although individual females can breed as yearlings, most breeders in a given population are $\geq$2 years old (Squires and Reynolds 1997).

Goshawk territorial behaviour has been observed as early as February in the mid-Atlantic states (Speiser and Bosakowski 1991); mid-March in British Columbia (Beebe 1974). On the Queen Charlotte Islands, courtship displays of the Queen Charlotte Goshawk were recorded as early as 6 March (Chytyk *et al.* 1998) and are thought to commence during the last week of February (Chytyk and Dhanwant 1999). Some pairs may remain near the nest year-round (Doyle and Smith 1994). Recent telemetry work on Vancouver Island suggested that most male Queen Charlotte Goshawks remain on or near the nesting territory year round, while females generally disperse further from the nest site during the winter months (McClaren 1999).

Eggs are generally laid between mid-April and late May (McGowan 1975; Reynolds and Wight 1978; Bull and Hohmann 1994; Iverson *et al.* 1996); but as early as 7 April has been reported in British Columbia (Campbell *et al.* 1990). Egg-laying may be delayed during cold, wet springs and at higher elevations (Squires and Reynolds 1997). On Vancouver Island and the Queen Charlotte Islands it is thought that egg laying occurs during late April and early May (E. McClaren pers. comm.; Chytyk and Dhanwant 1999).

The incubation period ranges from 28 to 32 days per egg (Beebe 1974; McGowan 1975; Reynolds and Wight 1978), and begins with the first or second egg laid (Beebe 1974; Squires and Reynolds 1997). Incubation is performed primarily by the female. During this period, males hunt and deliver food to the female (Brown and Amadon 1968), but occasionally incubate (Lee 1981, E. McClaren pers. comm.). Hatching and fledging dates are variable, ranging from 13 May to 25 June, and 25 June to 28 July, respectively (McGowan 1975; Reynolds and Wight 1978; Bull and Hohmann 1994). In British Columbia, the earliest recorded fledging date is 25 June (Dease Lake), and the latest was calculated to be in the last week of August (Campbell *et al.* 1990).

On Vancouver Island, seven broods of Queen Charlotte Goshawks fledged from early to mid-July 1997 (McClaren 1997). Fledging generally occurred during the first two weeks of July on the Queen Charlotte Islands (Chytyk and Dhanwant 1999). Goshawks have a relatively long post-fledging dependency period that can be several weeks in duration (Kennedy *et al.* 1994). In southeast Alaska, all juvenile Queen Charlotte Goshawks appeared to disperse from natal areas before 5 September (Titus *et al.* 1995). Natal dispersal on Vancouver Island and the Queen Charlotte Islands generally occurred during late August (E. McClaren pers. comm.; Chytyk and Dhanwant 1999).

In North America, clutch sizes usually range between two and four eggs with a mean clutch size of 2.7 eggs (Squires and Reynolds 1997). In British Columbia, clutch sizes also range from two to four eggs (Campbell *et al.* 1990), but three eggs is the norm (Beebe 1974). Nesting success is highly variable but, in most studies, 80-94% of nest attempts produced at least one fledgling (Reynolds and Wight 1978; Bull and Hohmann 1994; Squires and Reynolds 1997). In the Yukon, the average number of fledglings varied from 0/nest to 3.9/nest (Doyle and Smith 1994). On the Olympic Peninsula of Washington, 2.3 young fledged/breeding attempt in 1996, and 2.0 in 1997 (Finn *et al.* 1998). See Appendix B for additional productivity data.

On Vancouver Island, productivity for 56 nesting attempts between 1994-1998 averaged 1.7 fledglings/nest; with annual rates varying between 1.4 and 2.2 fledglings/nest (McClaren 1999). On the Queen Charlotte Islands, productivity was variable: 1 nest with 2.0 fledglings in 1995; 2 nests averaging 1.5 fledglings/nest in 1996; 1 nest with 1.0 fledgling in 1997; and 1 nest with 0 fledglings in 1998 (Chytyk and Dhanwant 1999). Nest failure followed by a replacement clutch, has been observed (Johnsgard 1990), but is likely rare, as goshawks require the full spring and summer season to nest successfully (Squires and Reynolds 1997).

Variation in goshawk productivity is associated mainly with prey abundance (McGowan 1975; Crocker-Bedford 1990a; Doyle and Smith 1994) and habitat structure for accessibility to prey (Widen 1989; Crocker-Bedford 1990a; Beier and Drennan 1997). There is evidence that nestling survival is directly dependent on food supply due to starvation or siblicide (Estes *et al.* 1999), but an alternative explanation is that higher food abundance allows adults to remain longer within the nest area, thus decreasing predation of nestlings (Ward and Kennedy 1996). Initiation of breeding is generally dependent on prey availability, the presence of a suitable mate, and the availability of unoccupied suitable nesting habitat (McGowan 1975; Hennessy 1978; Reynolds and Wight 1978; Doyle and Smith 1994; Iverson *et al.* 1996; Finn 1997). On Vancouver Island, low productivity for Queen Charlotte Goshawks in 1995 was thought to be related to low abundance of Red Squirrel (*Tamias hudsonicus*), a primary prey species (Ethier In prep).

Weather, age of breeders, nestling predation, adult mortality, disease and human disturbance may also affect productivity (Squires and Reynolds 1997). Siblicide occurs during food shortages (Squires and Reynolds 1997; Estes *et al.* 1999). Fishers (*Martes pennanti*) were taking eggs, nestlings, and adult females in a Wisconsin population and an increasing Fisher population was thought to be one cause of reduced goshawk

productivity (Erdman *et al.* 1998). Other predators of goshawk nestlings include Great Horned Owl, and mammals such as Wolverine (*Gulo gulo*) (Doyle 1995). On the Queen Charlotte Islands, Raccoon (*Procyon lotor*) was recently suspected of preying upon a Queen Charlotte Goshawk nest (Chytyk and Dhanwant 1999).

Survival

Estimates of mortality rates of adults and fledged juveniles are difficult to make and few data exist for North American populations. Some specific causes of adult mortality are starvation, predation, disease, and direct and indirect killing by humans (Beebe 1974; Snyder and Wiley 1976 in Palmer 1988; Newton 1979; Duncan and Kirk 1995; Squires and Reynolds 1997).

Long-term survival rates of juveniles and recruitment rates into the breeding population are unknown. European research indicates that mortality is highest in the first year (58-64%) and decreases with age (Newton 1979). In Arizona, estimated annual survival was 87% for females >1 year old and 69% for males >1 year old (Kennedy 1997; Squires and Reynolds 1997). In southeast Alaska, annual survival of adult Queen Charlotte Goshawks was 76%; late winter and early spring was the period of highest mortality (Titus *et al.* 1995). During the winter of 1998 on Vancouver Island, 7 of 20 radio tagged adult Queen Charlotte Goshawks (4 females and 3 males) died (McClaren 1999). The majority of recovered bodies were badly emaciated and necropsies indicated starvation as the primary cause of death.

Palmer (1988) suggests a maximum life span of 20 years in North America, but provides no supporting evidence. Goshawks in Europe have been known to live up to 19 years, both in the wild and in captivity (Newton 1979).

Physiology

Throughout most parts of its range, in particular the southern portions, goshawks tend to nest on north-facing slopes that provide cool micro-environments (Reynolds *et al.* 1982; Squires and Reynolds 1997). On the Queen Charlotte Islands, 5 active Queen Charlotte Goshawk nests were found on warmer, southwest aspects that ranged between 200° and 245° (Chytyk and Dhanwant 1999; Chytyk *et al.* 1999). This contrasts with nests on Vancouver Island where 9 were on aspects between 1°-90°, 4 were on aspects between 91°-180°, 10 were on aspects between 181°-270°, and 8 were on aspects between 271°-360° (McClaren 1998, 1999). Elsewhere, there is no clear pattern for aspect of goshawk nests: northeast aspects in Kispiox Forest District,northwest British Columbia (Mahon and Franklin 1997) andsoutheast Alaska (Titus *et al.* 1994); southeast aspects in the Lakes Forest District, northwest British Columbia (Mahon and Doyle 1999); or southerly aspectsin southeast Alaska (McGowan 1975).

On the Queen Charlotte Islands, 4 of 5 active Queen Charlotte Goshawk were found in dead western hemlocks. This contrasts with other nest trees across its range which tend to be live trees (Beebe 1974, Reynolds *et al.* 1982, Crocker-Bedford and

Chaney 1988, Titus *et al.* 1994, Squires and Reynolds 1997). On Vancouver Island, only 3 of 32 known Queen Charlotte Goshawk nests were located in dead trees (E. McClaren pers. comm.). On the Queen Charlotte Islands, Queen Charlotte Goshawks may select dead trees because they provide direct exposure to solar heat that may help to regulate nest temperatures, since summer months there are generally wet and relatively cool (Chytyk and Dhanwant 1999). Nesting in exposed dead trees may also be explained by the absence of Great Horned Owls breeding on the archipelago (Campbell *et al.* 1990). Great Horned Owls are known to prey on young and adult goshawks and other raptors (Squires and Reynolds 1997).

Heavy rainfall is thought to impact reproductive success of goshawks (Penteriani 1997), and may be an important factor in coastal British Columbia given its relatively high rainfall. During a ten year study in the Mediterranean, Penteriani (1997) found that cold, wet springs delayed nest initiation, and heavy levels of annual rainfall between 60-120 mm corresponded with years that had the highest incidence of nest failure. April and May were suggested as the most critical months when weather could affect nest productivity. Other studies also stress the negative impact that precipitation levels, particularly in spring, have on nest productivity for goshawks and other raptor species (Kostrzewa and Kostrzewa 1990).

On the Queen Charlotte Islands, the average annual precipitation is 1359 mm at Sandspit (ne corner Moresby Island) (Environment Canada 2000), a full magnitude greater than the threshold limit in the Mediterranean. In Sandspit, March, April and May have on average 104 mm, 95 mm and 62 mm of precipitation per month respectively. On Vancouver Island, average annual precipitation levels vary from 857 mm in Victoria to 3295 mm in Tofino (Environment Canada 2000). These relatively high precipitation levels, when compared to other regions such as interior North America or the Mediterranean, suggest the Queen Charlotte Goshawk has adapted to wetter environments. However, high rainfall in coastal British Columbia may have an adverse affect on Queen Charlotte Goshawk productivity.

Movement

Goshawks are a nomadic species but are probably resident year-round in most years throughout most of its range. Migration, when it occurs, is linked to food shortages (Squires and Reynolds 1997). Residency appeared to be typical for the Queen Charlotte Goshawk in southeast Alaska (Crocker-Bedford 1994; Titus *et al.* 1994; ADFG 1996). Adults dispersed variable distances from their nesting areas after breeding; some used overlapping summer and winter ranges whereas others dispersed as far as 90 km from their nest area for the winter (ADFG 1996). On Vancouver Island and Queen Charlotte Islands, the Queen Charlotte Goshawk is almost certainly resident (Taverner 1940; Beebe 1974; Campbell *et al.* 1990). For example, on Vancouver Island, recent data from 17 radio-tagged birds showed a maximum movement from nest sites of >100 km from July through March (E. McClaren unpubl. data). In addition, several radio-tagged females were "lost" during the winter months, suggesting that they may have dispersed much further during winter.

Juvenile residency was well-documented in southeast Alaska when 23 of 27 independent juveniles dispersed an average of 60 km from their natal site; then remained fairly consistently in winter-use areas (ADFG 1996). However, juveniles usually must disperse from their natal areas to find unoccupied habitat and, therefore, tend to disperse greater distances than adults. In another study in southeast Alaska, 14 radio-tagged juvenile Queen Charlotte Goshawks dispersed from nest areas 5 to 7 weeks (August 5 to September 5) after fledging, and were tracked to distances ranging from 16 to 151 km from their natal sites (Titus *et al.* 1994).

Nutrition

Goshawks prey on a wide range of small to medium-sized mammals and birds depending on season and region. Geography and variation in prey fauna available in different forest types explain much of the variation in local goshawk diets (R. Reynolds pers. comm.). During the nesting season, mammals were taken more often in interior Alaska, Arizona, Nevada, Utah, and Yukon; birds were taken more often in southeast Alaska, California, New Mexico, and Oregon (Titus *et al.* 1994; Squires and Reynolds 1997). In Washington, coastal goshawks took more birds (53%) than mammals, compared to interior goshawks (47%), with squirrels, grouse, and Snowshoe Hares (*Lepus americanus*), being the main prey (Watson *et al.* 1998). Common prey species include tree squirrels, ground squirrels, rabbits, Snowshoe Hare, woodpeckers, grouse, corvids, and various large songbirds (Squires and Reynolds 1997). Goshawks occasionally use carrion (Squires 1995).

In southeast Alaska, the most common prey of Queen Charlotte Goshawks were Steller's Jay (*Cyanocitta stelleri*), Blue Grouse, Spruce Grouse (*Dendragapus canadensis*), Varied Thrush (*Ixoreus naevius*), Red Squirrels, and woodpeckers. Smaller numbers of Sharp-shinned Hawk (*Accipiter striatus*), alcids, yellowlegs, ptarmigan, and Northwestern Crow (*Corvus caurinus*) were taken (Titus *et al.* 1994). In southeastern Alaska, of the ten most common prey species for Queen Charlotte Goshawks, none were expected to benefit from clearcut logging and most were likely to decline (Iverson *et al.* 1996); although Blue Grouse were likely to increase during the earliest seral stages.

On the British Columbia coast, Beebe (1974) thought the Queen Charlotte Goshawk preyed mainly on Steller's Jays and Varied Thrushes on Vancouver Island; on the Queen Charlotte Islands, he thought they take mainly Northwestern Crows. However, Chytyk and Dhanwant (1997) found Red Squirrel, Red-breasted Sapsucker (*Sphyrapicus ruber*), Blue Grouse, Varied Thrush, and Hermit Thrush (*Catharus guttatus*) to be important prey for pairs nesting in inland parts of the Queen Charlotte Islands, and found no evidence of predation on crows. A possible explanation may be that the Northwestern Crow occurs most abundantly near marine coasts and can become rare even a few kilometres inland (Campbell *et al.* 1997), and Beebe spent most of his field time along the coast. An analysis of 44 pellets collected from the base of nest trees on the Queen Charlotte Islands in 1996 showed that Red Squirrel (44%) and various songbirds (47%) were the major prey of nesting pairs during the breeding season (Roberts 1997).

Recent evidence on Vancouver Island, suggested Red Squirrels may be the most important prey species, at least during early parts of the breeding season (McClaren 1997; T. Ethier pers. comm.); other prey included Varied Thrush, Northern Flicker (*Colaptes auratus*), Red-breasted Sapsucker, Marbled Murrelets (*Brachyramphus marmoratus*) (T. Ethier pers. comm.), and bats (J. Deal pers. comm.).

Behaviour/Adaptability

Over the past century, population declines of some subspecies of goshawks have been reported, with habitat loss through logging identified as the primary cause (Widen 1997). However, if taller, older forests are not available, goshawks are capable, to some degree, of using younger and denser forests (Doyle and Smith 1994; Bosakowski and Vaughn 1996; Bosakowski *et al.* 1999). But there are limits to this adaptability; for example, the minimum age of stands used for nesting was 40 years in the Cascade Mountains of western Washington (Bosakowski *et al.* 1999), and 75 years in an Idaho Douglas-fir forest (Lilieholm *et al.* 1994). These younger aged forests are likely the lower age limit of forests that can provide trees with the structural capability to hold goshawk nests.

On Vancouver Island, the Queen Charlotte Goshawk is known to nest in second-growth stands that are >50 years old (E. McClaren pers. comm.). Nests in second-growth stands had similar productivity (1.9 fledglings/active nest for 14 nests) to nests in old-growth forests (1.7 fledglings/active nest for 35 nests) (McClaren 1999). Reoccupancy rates were similar between old-growth and second-growth stands (E. McClaren pers. comm.).

Goshawks are, at times, sensitive to disturbance at or near the nest, and may abandon a nest during incubation or the nestling period, if disturbed by industrial activity, or other human presence (Speiser and Bosakowski 1987; Reynolds 1989; Speiser 1992; Boal and Mannan 1994; Squires and Reynolds 1997). Data from eastern North America, showed that goshawks nest farther from human habitations and paved roads than random sites (Bosakowski and Speiser 1994). However, goshawks can habituate to routine human activities at some distance from the nest. For example, in Arizona, noise from logging trucks that passed by approximately 500 m from 2 active nests elicited no discernible response from a brooding adult female or a lone juvenile (Grubb *et al.* 1998). In the Cariboo region of central British Columbia, one nest successfully fledged young in 1996, even though logging and road-building occurred nearby during the nesting season (Bosakowski and Rithaler 1997). On Vancouver Island, 2 active Queen Charlotte Goshawk nests occurred within 200 m of an active logging mainline road. Another nest produced 2 fledglings even when tree felling and yarding occurred within 75 m of the nest during the early to mid nesting season (D. Doyle pers. comm.), and a nest within 200 m of a heli-logging operation during the late incubation and nestling phase fledged 1 young (E. McClaren pers. comm.).

It is likely that the risk of human activity that causes nest abandonment or affects productivity is a function of timing in breeding chronology (declining risk as the nesting

season progresses), distance (increasing risk as distance shortens), and intensity of activity (increasing risk with increasing intensity).

POPULATION SIZE AND TRENDS

Inventory Results

Goshawks are a rare to uncommon forest raptor throughout forested parts of British Columbia; until recently, provincial records of nesting were relatively few (Campbell *et al.* 1990). During the last few years, inventories of nesting goshawks have occurred in several regions of British Columbia in response to the high conservation priority placed on this species. Surveys in coastal British Columbia located 41 Queen Charlotte Goshawk nests on Vancouver Island during 1991-1999: 1 nest-1991, 4 nests-1994, 6 nests-1995, 8 nests-1996, 9 nests-1997, 7 nests-1998, 6 nests-1999 (McClaren 1999; D. Doyle pers. comm.). On the Queen Charlotte Islands, 5 active nests have been reported during 1995-1999: 1 nest-1995, 2 nests-1996, 0 nests-1997, 1 nest-1998, 1 nest-1999 (Chytyk and Dhanwant 1999; Chytyk *et al.* 1999).

Population Estimates

A habitat capability model developed for the Queen Charlotte Goshawk, estimated 1,700 pairs in coastal British Columbia and 800 pairs in southeast Alaska (Crocker-Bedford 1990b). The British Columbia estimate included the coastal mainland even though it is uncertain if the Queen Charlotte Goshawk occurs there. More recent refinements to the model reduced the estimate for southeast Alaska to 100-200 pairs (Crocker-Bedford 1994). Although a new estimate for British Columbia was not made, Crocker-Bedford (1994) suggested the British Columbia population was substantially less than 1,700 pairs. This conclusion seems reasonable given the results of recent surveys on Vancouver Island (McClaren 1997, 1998, 1999) and the Queen Charlotte Islands (Chytyk *et al.* 1998; Chytyk and Dhanwant 1999). However, the accuracy of these estimates are questioned by other goshawk experts. Even so, results from the above-mentioned surveys suggest that densities, although uncalculated as yet, on Vancouver Island are possibly much higher than on the Queen Charlotte Islands.

If we use the maximum of Crocker-Bedford's (1994) revised population estimate for southeast Alaska (200 pairs), and apply the same reduction (25% of his 1990 estimate) to his original British Columbia estimate (1,700 pairs), then there would be an estimated 425 pairs of Queen Charlotte Goshawks in coastal British Columbia.

The Queen Charlotte Goshawk is known to nest on large coastal islands (West Cracroft, Quadra and E. Thurlow islands (E. McClaren pers. comm.) and perhaps the north and central coastal mainland of British Columbia (Campbell *et al.* 1990; Crocker-Bedford 1994). The coastal mainland is comprised of many rugged small islands and islets and steep glacial fjords and high alpine areas. These terrain types offer few areas of preferred Queen Charlotte Goshawk nesting habitat, i.e., lower elevation moderate

slopes (McClaren 1999; Chytyk and Dhanwant 1999). It is thought that the drier biogeoclimatic zones on the east side of Vancouver Island contain the best Queen Charlotte Goshawk nesting habitat in British Columbia (D. Doyle pers. comm.). The coastal mainland is somewhat wetter than eastern Vancouver Island and, possibly, does not offer as good quality nesting habitat as is found on Vancouver Island.

We estimate that about 10% of Vancouver Island, mainly in the northeast, has been inventoried for nesting Queen Charlotte Goshawks (D. Doyle pers. comm.). Forty-one Queen Charlotte Goshawk nests have been reported by McClaren (1999) during the last 5 years. If we assume that those 41 nests have been found in about 10% of the landscape, that the area surveyed is relatively high quality goshawk, and the remainder of unsurveyed habitat is somewhat lower quality, then a reasonable population estimate for Vancouver Island may be about 300 pairs.

We suggest that a conservative estimate of the relative density of Queen Charlotte Goshawks on the Queen Charlotte Islands is about 50% of that found on Vancouver Island, for the following reasons:

1. Generally, it is thought that goshawk territories increase in size the higher the latitude (Squires and Reynolds 1997). The Queen Charlotte Islands is almost 4° latitude further north of Vancouver Island and, consequently, territory size on the Queen Charlotte Islands is likely slightly larger than on Vancouver Island. On Vancouver Island, the closest inter-territory distance is 3.2 km, while a cluster of 5 territories averaged approximately 6 km apart (McClaren 1999). Using the average of 6 km inter-territory distance as the diameter of a circular territory, a rough estimate of territory size for Vancouver Island would be about 2800 ha. Territory sizes in southeast Alaska and, based on our impressions, probably the Queen Charlotte Islands, appear to be considerably larger than those suggested by data for Vancouver Island.

2. The Queen Charlotte Islands contain proportionately less potential nesting habitat than Vancouver Island. The northeast portion of Graham Island, the northern of the two large islands on the Queen Charlotte archipelago, is a large area of stunted lodgepole pine forest and open bogs, generally considered low quality nesting habitat (Johnsgard 1990; Squires and Reynolds 1997). The southern portion of Moresby Island, the southern of the two large islands, is mostly rugged, small islands and islets, that do not contain many moderate slopes or flatter valley bottoms, preferred nesting habitat of Queen Charlotte Goshawks (McClaren 1999; Chytyk and Dhanwant 1999). Relatively, Vancouver Island does not have many stunted forests, islands or islets, however, it does have a greater proportion of alpine and subalpine areas. As well, the majority of second growth found on the Queen Charlotte Islands is relatively young and generally not suitable for nesting habitat (Chytyk and Dhanwant 1997). Large-scale logging did not start to impact the landscape significantly until the mid to late 1960s on the Queen Charlotte Islands and, consequently, there are few large areas of second growth >50

years old. This contrasts with Vancouver Island where the rate of commercial logging accelerated in the 1940s and, as a result, there is significantly more areas of second-growth forest old enough to provide nesting habitat.

3. There is a smaller prey base on the Queen Charlotte Islands than on Vancouver Island. Provincial records show that several key prey species of grouse, woodpecker and medium-sized songbird are absent from the Queen Charlotte Islands, but are present on Vancouver Island (Campbell *et al.* 1990, 1997). The absence of these species on the Queen Charlotte Islands may have a more dramatic effect on Queen Charlotte Goshawk populations during winter months (Chytyk and Dhanwant 1999) when starvation is a major cause of death, as noted on Vancouver Island (McClaren 1999).

4. Population inventories conducted on Vancouver Island and the Queen Charlotte Islands provide some evidence for lower population densities on the Queen Charlotte Islands. Inventories have been conducted on Vancouver Island between 1994-1999 and on the Queen Charlotte Islands between 1995-1998. During the two inventory periods, 41 nests were found on Vancouver Island while 5 nests (approximately 12% of 41) were found on the Queen Charlotte Islands. Because survey efforts were greater on Vancouver Island than on the Queen Charlotte Islands, but not sufficiently greater to account for the much higher success in nest detection, we suggest densities on the Queen Charlotte Islands are lower rather than higher.

The Queen Charlotte Islands has an area of 9,596 km^2 and is roughly 31% the size of Vancouver Island at 31,284 km^2. Using the 31% geographical area proportion and the conservative estimate of the population density on the Queen Charlotte Islands being half that of Vancouver Island, then, we suggest that the Queen Charlotte Islands has an estimated population of approximately 50 pair of Queen Charlotte Goshawks. These estimates suggest that about 14% (41 of 300 estimated pairs) on Vancouver Island, and 10% (5 of 50 estimated pairs) on the Queen Charlotte Islands of the population has been documented by surveys. These percentages seem reasonable given the areas surveyed, the results of those surveys, and the area remaining to be surveyed.

The status of goshawks breeding on the coastal mainland is uncertain. They may be Queen Charlotte Goshawks, as assumed by Crocker-Bedford (1990, 1994), *A.g. atricapillus*, or a mixture of both. However, if we ignore the possible population on the mainland coast and other coastal islands, we suggest that a conservative population estimate of Queen Charlotte Goshawks in British Columbia is 350 pairs. If we include the mainland coast and other coastal islands, then we estimate >425 pairs.

Population Trends

Population trends are unknown in British Columbia and, apparently, anywhere else in western North America. Some studies which report declines have apparently not applied

sufficiently rigorous statistical methods to determine trends (Kennedy 1997). However, Crocker-Bedford (1998) and Smallwood (1998) point out that it may be nearly impossible (due to practical factors such as costs) to obtain a data set for this raptor species with sufficient rigour to prove any trend statistically. For the Queen Charlotte Goshawk, Crocker-Bedford (1990b) estimated that habitat for 1150 pairs has been converted to early seral forest in southeast Alaska and coastal British Columbia due to logging of old-growth forests. Even if Crocker-Bedford's predictions were inaccurate (Kennedy 1997, 1998), he suggested (Crocker-Bedford 1998), and we agree, the trend seems to be inevitably downward for Queen Charlotte Goshawks in British Columbia because of the extent of logging of old-growth and mature second-growth forests on the coast.

LIMITING FACTORS

Food

Goshawk populations are regulated by several factors but are probably strongly regulated by food availability (McGowan 1975; Linden and Wikman 1983; Widen 1989; Doyle and Smith 1994; Crocker-Bedford 1998; Ethier In prep). Prey availability (forest structure for hunting) is often more important than prey abundance (Widen 1989: Beier and Drennan 1997; Crocker-Bedford 1998). This has elevated the idea of management of habitat for goshawk prey species to compliment the management for nesting habitat (Iverson *et al.* 1996; Widen 1997). This approach is favoured by Crocker-Bedford (1990a), who speculated that reduced re-occupancy at protected nest stands following the removal of trees from the surrounding landscape was attributable to a reduction in suitable prey habitat and accessibility, and hence a reduction in foraging opportunity. Breeding pair density may depend on the amount of habitat where suitable prey abundance is above some threshold level, and is accessible enough that the chance of successful capture in the habitat is worth the time and energy expended (Crocker-Bedford 1998).

Logging in important foraging habitat likely has effects disproportionate to the size of the habitat; on the other hand, logging that misses important foraging habitat may have little or no effect on home range size or breeding density (Crocker-Bedford 1998). It may be possible, in managed forests with certain forest types, to improve habitat for goshawk prey species, and nesting habitat, through careful treatments using standard forest harvesting techniques (Reynolds *et al.* 1992); but such treatments are currently at the discretion of the forest licencee, private landowner, or Ministry of Forests (J. Deal pers. comm.).

Habitat

Breeding habitat loss or fragmentation, and its effect on prey availability and nesting habitat, is the single most significant threat to the long-term viability of the Queen Charlotte Goshawk in British Columbia (Cooper and Stevens 2000). Although data on large-scale population trends are equivocal, many studies have concluded that logging activities, especially clearcut logging, can adversely affect goshawks (Hennessy 1978; Reynolds and Wight 1978; Reynolds *et al.* 1982, 1992; Moore and Henny 1983; Hall 1984; Mannan and

Meslow 1984; Crocker-Bedford and Chaney 1988; Reynolds 1989; Crocker-Bedford 1990a, 1994, 1998; Patla 1990, 1991; Marshall 1992; Austin 1993; Harris *et al.* 1994; see references in Block *et al.* 1994; see references in Duncan and Kirk 1995; Iverson *et al.* 1996); and can lead to local extirpation when the extent of logging is great (Petty 1989; Kenward *et al.* 1991 in Crocker-Bedford 1994; Crocker-Bedford 1998).

Because large-volume stands have high economic value and are also preferred as nesting habitat by Queen Charlotte Goshawks, logging is usually concentrated in forests with the highest quality goshawk habitat. Typical forestry practices such as partial cutting, understorey brushing, patch cutting and clear-cutting, result in a reduction in stem density and canopy volume, which reduces current habitat quality for nesting or foraging (Crocker-Bedford 1990b; Iverson *et al.* 1996). Therefore, logging may reduce the ability of a landscape to provide a suitable mixture of structural habitat attributes needed by goshawks, although individual logged areas may recover over time as suitable habitat. It is hypothesized that the cumulative effect of logging may result in fewer pairs, less opportunity to locate a new mate, higher proportions of habitat unoccupancy (Crocker-Bedford 1994), and larger home ranges (Crocker-Bedford 1998).

In coastal British Columbia, second-growth stands on good growing sites can become suitable for nesting Queen Charlotte Goshawks after 50 years, as several nests have been found in such stands on Vancouver Island (D. Doyle pers. comm.). If logging rotations of 100 years were standard, then provision of extensive amounts of suitable breeding habitat could be ensured. However, it is becoming increasingly common for second-growth stands that are in this age class and which have size and structure suitable for goshawks, to be logged because of the timber values represented by trees of that size. The result is that, once a stand is logged, it may be continually logged just as it is becoming suitable for goshawks. In such a scenario, these stands would never recover sufficiently to provide habitat suitable for breeding goshawks.

SPECIAL SIGNIFICANCE

Status

The United States Department of Interior (USDI Fish and Wildlife Service 1992 in Crocker-Bedford 1994) designated goshawks (including the Queen Charlotte Goshawk) as a Category 2 candidate species for Threatened or Endangered status in 1991; however, the Fish and Wildlife Service no longer maintains a list of Category 2 candidate species (USDI Fish and Wildlife Service 1996 in Iverson *et al.* 1996). Goshawks are on the Sensitive Species lists of the Pacific Southwest (1981), Southwest (1982), Intermountain (1992), Rocky Mountains (1993) and Alaska (1994) Forest Service Regions. At the state level, goshawks are listed as a high priority species by state working groups of Partners in Flight in Alaska, Arizona, California, Montana, Nevada and New Mexico. In June 1998, the U.S. Fish and Wildlife Service denied a listing of goshawks (including Queen Charlotte Goshawk) as an Endangered species in the contiguous United States west of the 100th meridian (USDI Fish and Wildlife Service 1998).

On the Pacific coast, the Queen Charlotte Goshawk is ranked as "Critically imperiled globally" or "Imperiled globally" (T1/T2), by the Alaska Natural Heritage Program (West 1993 in Duncan and Kirk 1995; West 1994). In 1994, the Queen Charlotte Goshawk was formally designated as a "species of special concern" by the Alaska Department of Fish and Game (Iverson *et al.* 1996). A petition to declare the Queen Charlotte Goshawk an Endangered species in the USA was denied in September 1997 (Federal Register 1997).

The Committee on the Status of Endangered Wildlife in Canada (COSEWIC) evaluated both subspecies that occur in Canada: the Queen Charlotte Goshawk (which occurs only in British Columbia) was designated Vulnerable, whereas Northern Goshawk (*A. g. atricapillus*) was designated Not at Risk (Duncan and Kirk 1995).

The British Columbia Conservation Data Centre (CDC) ranks the Queen Charlotte Goshawk as S2B, SZN (imperiled in British Columbia due to rarity and perceived threats to habitat). The Queen Charlotte Goshawk is currently on the British Columbia "Red List" as a candidate species for Endangered or Threatened status (Ministry of Environment, Lands and Parks 1999).

Geographic Isolation

The Queen Charlotte Goshawk is likely distributed from southeast Alaska south through coastal British Columbia to the Olympic Peninsula. Populations in southeast Alaska and the Olympic Peninsula undoubtedly intergrade with populations of *A. g. atricapillus* (Iverson *et al.* 1996). Populations on Vancouver Island are likely relatively insular. However, the potential for dispersal of individuals from/to the mainland coast is relatively high given that coastal islands provide natural bridges on northern Vancouver Island and the widest stretch of open water between southern Vancouver Island and the mainland is approximately 30 km. In 1999, a female that was radio tagged as a breeding adult on northern Vancouver Island was tracked in the autumn on the mainland directly across Johnstone Strait (D. Doyle pers. comm.).

The population of Queen Charlotte Goshawks on the Queen Charlotte Islands is likely the most insular of all populations. The Queen Charlotte Islands are separated from the nearest islands in southeast Alaska and islands adjacent to the British Columbia mainland by approximately 60 km. If the rate of migration and dispersal is relatively low, as suggested by most studies on the Queen Charlotte Goshawk (Titus *et al.* 1994, Iverson *et al.* 1996; McClaren 1997), then it is likely that the Queen Charlotte Island population is the most genetically distinct.

Conservation Urgency

The Queen Charlotte Goshawk population on the Queen Charlotte Islands provides the most concerns from a wildlife management perspective. Although sufficient data are lacking, we believe that the population density on the Queen Charlotte Islands is substantially lower than that found on Vancouver Island (Chytyk and

Dhanwant 1999; Cooper and Stevens 2000), and we suggest that the population of Queen Charlotte Goshawks on the Queen Charlotte Islands is about 50 pairs. This small population, because of its insularity, also likely represents the most genetically distinct population of Queen Charlotte Goshawks in North America. Consequently, the conservation and protection of the Queen Charlotte Islands population of Queen Charlotte Goshawks is paramount.

PROTECTION CURRENTLY PROVIDED

Section 34 of the *Wildlife Act* of British Columbia protects goshawks, their eggs, nestlings, and their nests when the nests are occupied. A *"nest"* is defined as a structure, or part of a structure, prepared by or used by a bird species to hold its eggs or offspring. A nest is considered occupied from the time it is under construction to when fledglings leave the nest.

Persecution (shooting, trapping, poisoning or any other measure of killing) of goshawks in British Columbia is illegal under section 34 of the *Wildlife Act*, though allowances can be made when domestic animals are being defended. Current penalties for conviction for offences under section 34 include a fine of up to $50,000 and six months in jail for a first offence.

Federal endangered species legislation is currently being developed. The National Accord for the Protection of Species at Risk has been signed by most of the provinces as of the spring of 1998. It states that any province that signs on to the accord commits to developing complementary programs or legislation to meet 14 areas listed on the accord. This includes protection of Red-listed species and their habitat and, therefore, would apply in British Columbia to the Queen Charlotte Goshawk.

The Forest Practices Code of British Columbia has several legal components for the protection of species at risk. Among them are legally established management practices designed to protect critical or limiting habitat of certain species at risk, including the Queen Charlotte Goshawk, that have been signed off as Identified Wildlife by the Chief Forester and the Deputy Minister of Environment, Lands and Parks (Sections 70 Operational Planning Regulation, B.C. Reg. 107/98) (Province of British Columbia 1999).

There has been no estimate of the population of Queen Charlotte Goshawks, or of the relative suitability of habitat that occurs in existing protected areas. Such an assessment was one recommendation in a recent review of the status of goshawks in British Columbia (Cooper and Stevens 2000). We agree that surveys for breeding pairs and habitat assessments in protected areas are required in order to adequately estimate the provincial population and to properly assess the urgency for conservation.

If we assume that the Queen Charlotte Goshawk is evenly distributed across forested areas, which is unlikely, and that most of the populations occur within the

Coastal Douglas-fir and Coastal Western Hemlock biogeoclimatic zones, then according to Table 1, about 10% of the population on Vancouver Island and 23% of the population on the Queen Charlotte Islands occurs in protected areas. If we assume that Vancouver Island has 300 pairs and the Queen Charlotte Islands has 50 pairs, then a maximum of 40 pairs may be conserved in protected areas.

EVALUATION

The Queen Charlotte Goshawk has a relatively restricted global range, and the bulk of this range occurs in coastal British Columbia. Population sizes in British Columbia are thought to be small, on the order of 350-425 breeding pairs, with most concentrated on Vancouver Island. Protected forested habitat, which may or may not contain Queen Charlotte Goshawks, is limited to about 12% on Vancouver Island and 23% on the Queen Charlotte Islands. Threats to habitat include large-scale industrial logging in habitats that appear to contain the highest value habitat. The two most important causes of concern are the continued harvesting of old-growth forests, and the shortening of rotations for the harvesting of second-growth timber. Fragmentation of contiguous old-growth forest may decrease food availability, decrease availability of suitable nesting habitat, reduce insolation qualities, and increase risk of predation and competition from species better adapted to fragmented forest, all of which are likely to lead to lower population sizes. The adaptability of the Queen Charlotte Goshawk to nesting in younger second-growth stands is uncertain and the long term effects of current logging practices may significantly compromise population stability.

The Queen Charlotte Goshawk has a small population size, a very restricted range in Canada, is subject to large-scale threats to habitat, and has a relatively low capability to increase populations. Long term potential threats of increased fragmentation of old-growth forests remain uncertain, but are likely negative. More positively, it has a widespread distribution within that restricted range, has some adaptability in utilizing second-growth forests, and has a current high legislated priority for habitat conservation. However, because threats to habitat will likely continue, populations appear to be small, and there is a very limited range, we suggest the status of the Queen Charlotte Goshawk should be changed from Vulnerable to Threatened in Canada.

TECHNICAL SUMMARY

Accipeter gentilis laingi
Northern Goshawk *Laingi* subspecies

Range of Occurrence in Canada: British Columbia

Extent and Area information	
• *extent of occurrence (EO)(km2):* Vancouver Is: Queen Char. Is.: Mainland coast / other islands: Total at minimum: *source: status report, pg 15, 4th paragraph*	31,284 *km2* 9,596 *km2* *uncertain* 40,880 km2
• *specify trend (decline, stable, increasing, unknown)*	unknown
• *are there extreme fluctuations in EO (> 1 order of magnitude)?*	no
• *area of occupancy (AO) (km2)*	not specified
• *specify trend (decline, stable, increasing, unknown*	Possible decline due to logging practises and shortened logging rotations source: pg 7 paragraph 3 Pg 16-17
• *are there extreme fluctuations in AO (>1 order magnitude)?*	no
• *number of extant locations*	n.a.
• *specify trend in # locations (decline, stable, increasing, unknown*	n.a.
• *are there extreme fluctuations in # locations (>1 order of magnitude*	n.a.
• *habitat trend: specify declining, stable, increasing or unknown trend in area, extent or quality of habitat*	Decline due to logging of old-growth forests, and shortened logging rotation. No quantitative information available
Population information	
• *generation time (average age of parents in the population) (indicate years, months, days, etc.)*	several years
• *number of mature individuals (capable of reproduction) in the Canadian population (or, specify a range of plausible values)*	
• Based on modified habitat capacity model: *source - status report, page 14, 2nd paragraph*	425 pairs = 850 individuals
Based on survey data, and various extrapolations Vancouver Is.: *source- status report, page 15, paragraph 4&5* Queen Char. Is.: mainland coast and other islands (taxonomy of these birds uncertain): Total = 425 pairs Excluding mainland, 350 pairs = 700 individuals	300 pairs 50 pairs 75 pairs =850 individuals
• *total population trend: specify declining, stable, increasing or unknown trend in number of mature individuals*	unknown
• *if decline, % decline over the last/next 10 years or 3 generations, whichever is greater (or specify if for shorter time period)*	
• *are there extreme fluctuations in number of mature individuals (>1 order of magnitude)?*	

• *is the total population severely fragmented (most individuals found within small and relatively isolated (geographically or otherwise) populations between which there is little exchange, i.e., .s 1 successful migrant / year)?*	No
• *list each population and the number of mature individuals in each*	Apparently only one population is involved. (Little is known about population structure. Movements and dispersal are described on pg 12, paragraphs 1&2, and on pg 4, paragraph 3.)
• *specify trend in number of populations (decline, stable, increasing, unknown)*	n.a.
• *are there extreme fluctuations in number of populations (>1 order of magnitude)?*	n.a.
Threats (actual or imminent threats to populations or habitats) [add rows as needed]	
Loss and degradation of habitat due to logging of preferred low-elevation, old-growth forest and mature second growth forest. *Source: status reportpg 7, paragraph 3; pg 16&17.*	
Rescue Effect (immigration from an outside source)	Low because of low numbers in Alaska
• *does species exist elsewhere (in Canada or outside)?*	Alaska
• *status of the outside (population(s)?*	"Species of special concern" for Alaska Dept of Fish & 100-200 pairs - *status report,* pf!. 14, *2nd paraf!.r.*
• *is immigration known or possible?*	yes
• *would immignants be adalJted to survive here?*	yes
• *is there sufficient habitat for immigrants here?*	Contingent on habitat conservation
Quantitative Analysis	Not available

ACKNOWLEDGEMENTS

Funding for the preparation of this status report was provided by the Canadian Wildlife Service, Environment Canada.

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Appendix A. Summary of breeding habitat data for Northern Goshawks in selected areas of North America.

Location	N	Nest Tree Height (m)	Nest Tree dbh (cm)	Mean Tree dbh (cm)	Nest Height (m)	Tree Density (no./ha)	Canopy Cover (%)	Source
Vancouver Island, BC*	16	32.9	69.7	-	14.3	-	-	1
Queen Charlotte Islands, BC*	7	31.4	81.6	-	20.7	-	-	2
Kispiox Forest District, BC	23	28.9	55.1	-	16.4	-	70.8	3
Cariboo region, B.C.	8	20.9	35.5	22.8	12.3	701	51.9	4
central Alberta	17	22.6	30.4	19.7	14.9	-	77.4	5
Washington, Cascades	12	32.0	-	48.3	19.2	-	60.0	6
Washington, Olympics	7	27.0	-	43.1	15.7	-	64.0	7
ne Oregon	12	34.0	65.0	-	15.0	-	81.0	8
n California	12	34.4	74.2	27.1	16.8	749	76.9	9
nw California	12	43	91	58	21	279	88	10
se Idaho	26	26	43	31	14	-	75	11
Mean	-	30.3	60.6	35.7	16.4	576.3	71.7	-

*Queen Charlotte Goshawk

[1]McLaren 1997, 1998, 1999; [2]Chytyk and Dhanwant 1998, 1999; [3]Doyle and Mahon 1998; [4]Bosakowski and Rithaler 1997; [5]Schaffer 1998; [6]Fleming 1987; [7]Fleming 1987; [8]Bull and Hohmann 1994; [9]Saunders 1982; [10]Hall 1984; [11]Patla 1997.